npdγ Guide Coils

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Status - Field Coils

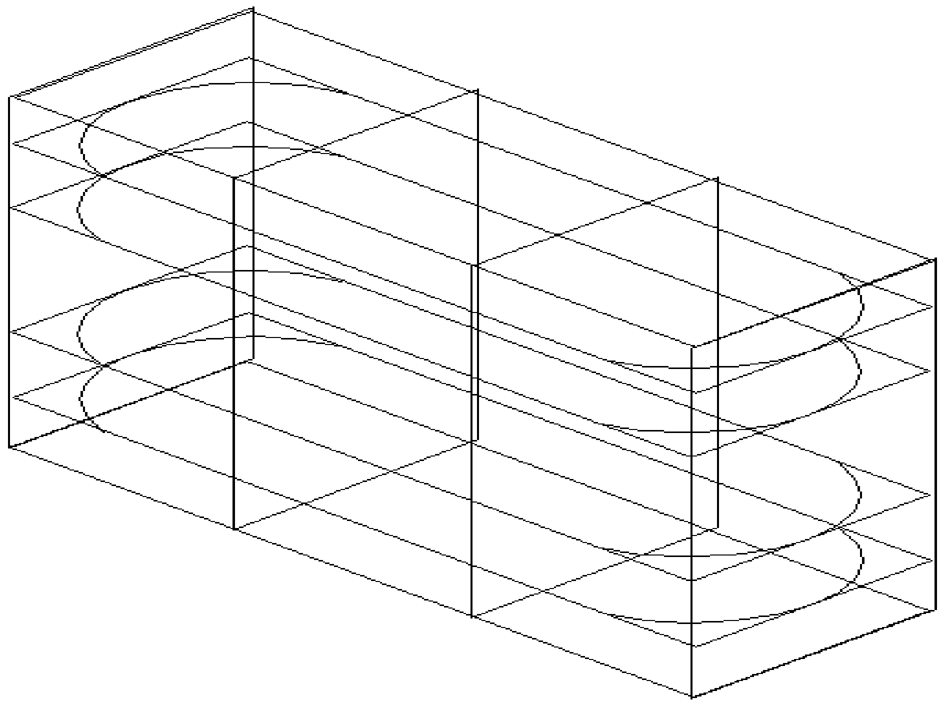
- Last of 4 coils being completed.
- Main power supply delivered and tested at UCB.
- Shim coils power supplies and spares ordered with delivery in 2 or 3 weeks.
- Fluxgate magnetometer ordered - may be a UCB by now.
- Stand to be constructed after T. Case return from Europe.
- Don't see a problem (at this point in time) with system being delivered to LANL in Spring.

- Installation at LANL: (Case, Carlini, technicians?)

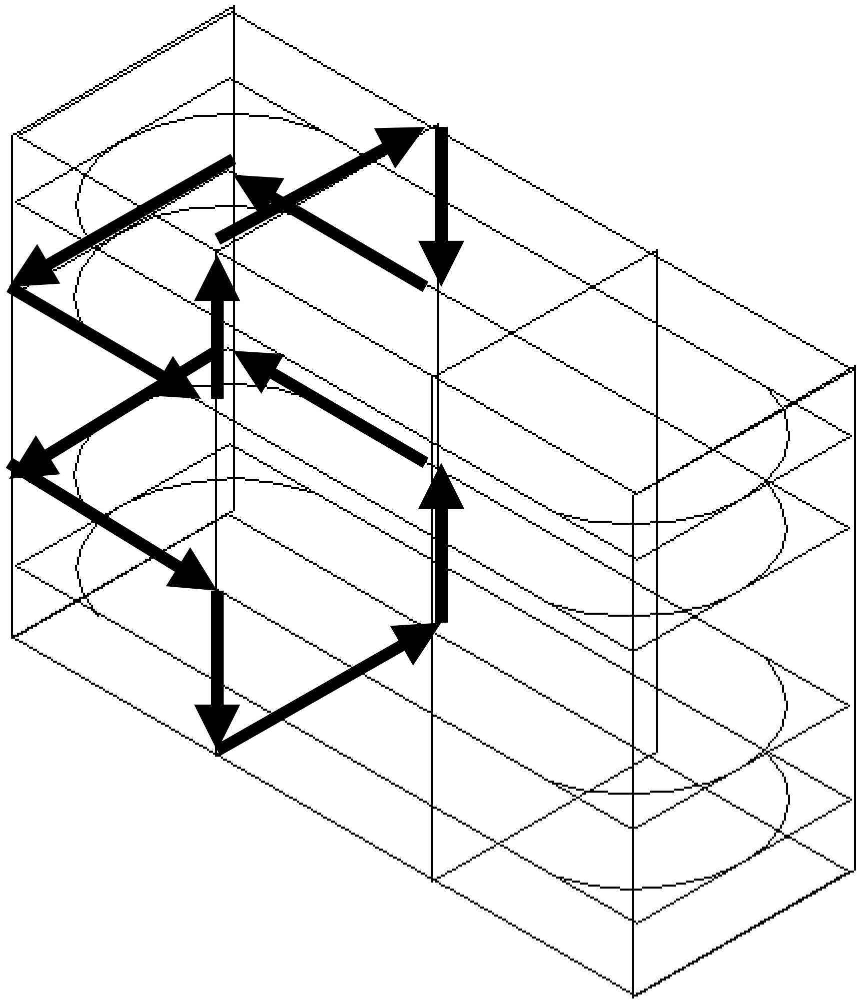
  - First installation - coils, stand, PS, shims, cables, controls into empty cave. ~1 week
  - Debugging, field mapping, placement of initial shim coils. ~2 weeks
  - Removal. ~0.5 weeks
  - Final installation, field mapping, & "final" shim coil placement with apparatus . ~3 weeks

Basic Concept

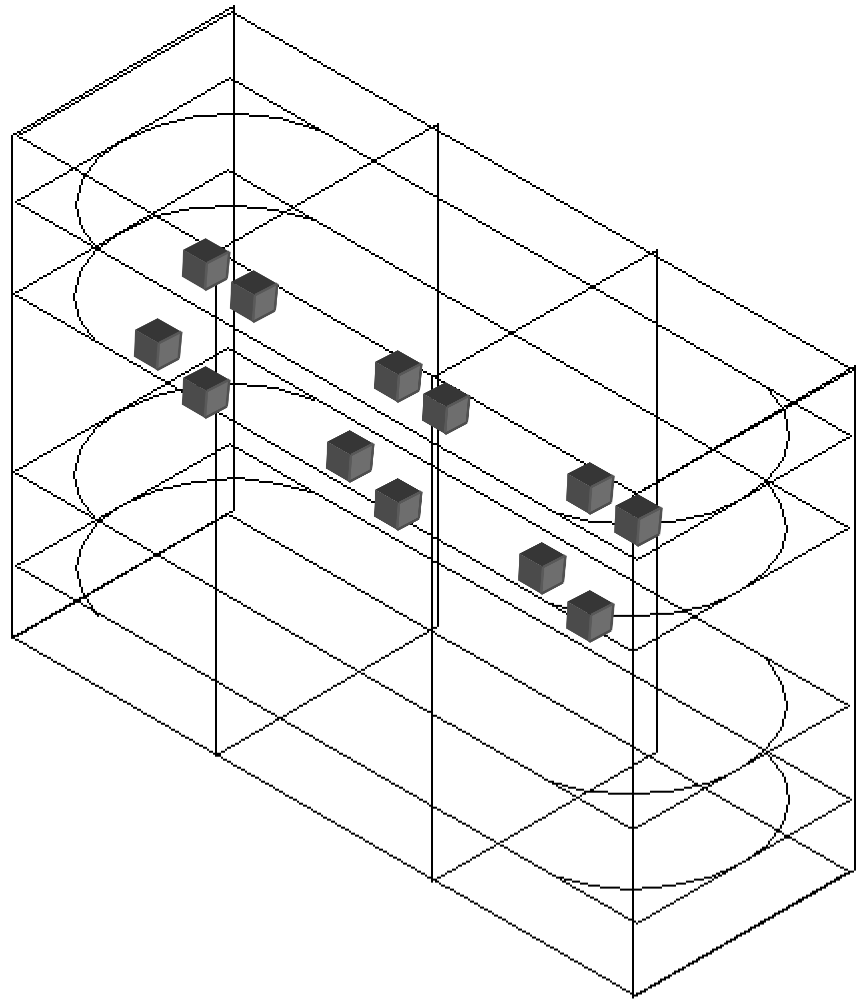
Basic Concept (4 racetrack, curved or bedstead) plus iterative custom shims on sight.



•“Custom” shims (frame and a few examples, intend to use stranded cable)



- Measuring the field (1mrad accuracy using surveyors level)



	Main turns of 7AWG	Shim turns of 12AWG
Top	36+2+1	12
Inner	21+2+1	12
Inner	21+2+1	12
Bottom	36+2+1	12

Main Power Supply and Guide Coils

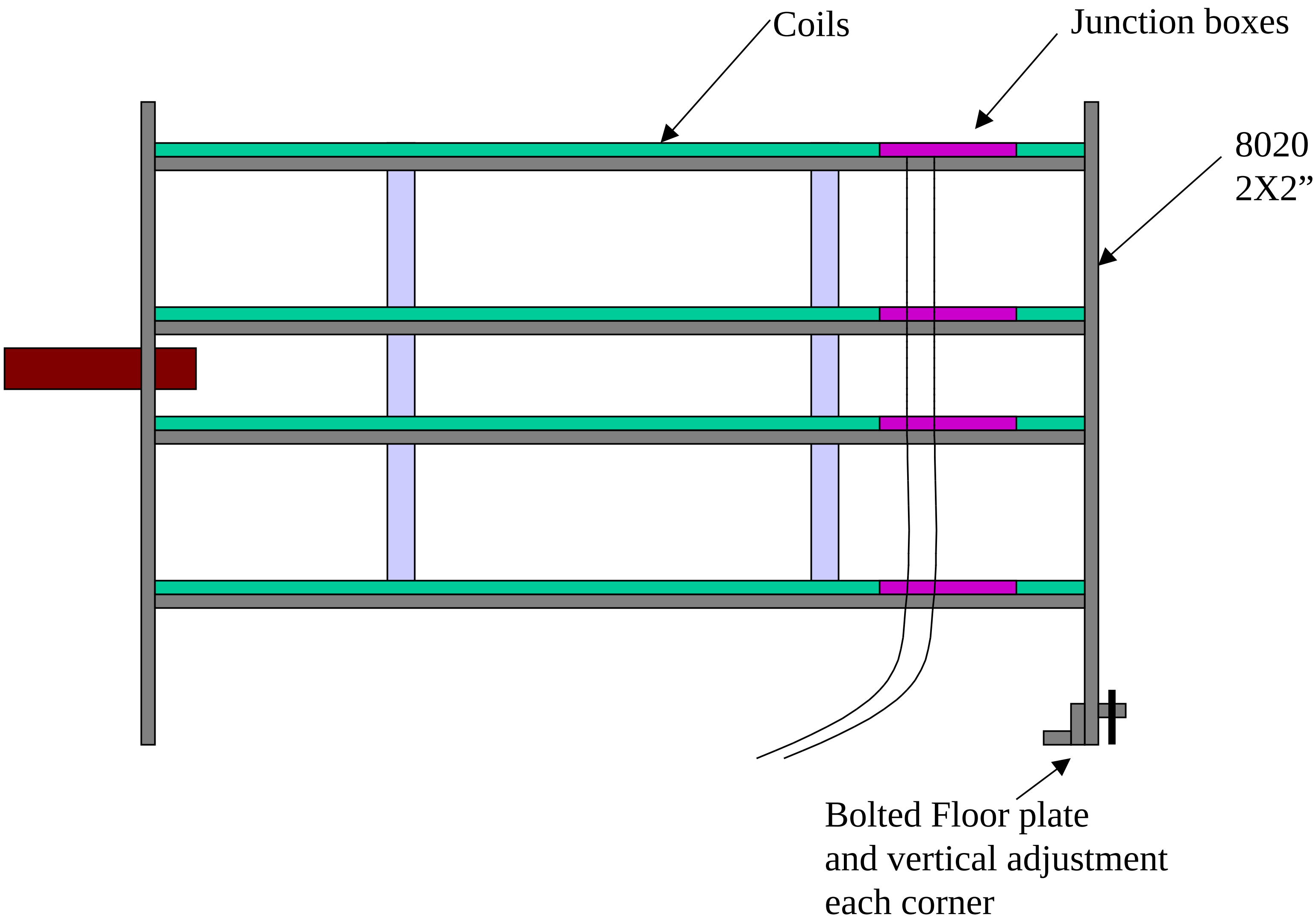
Danfysik Main Power

- Rating 25A 50V
- Load 1-2Ohm
- Cooling 4L/min 25-35deg C water
  (De-ionized is best, but at least should be filtered,
  we used Berkeley tap water for the tests)
- Tested with 1.5Ohm dummy. 16bit regulation.
- Smooth polarity reversal. Approx 10 seconds

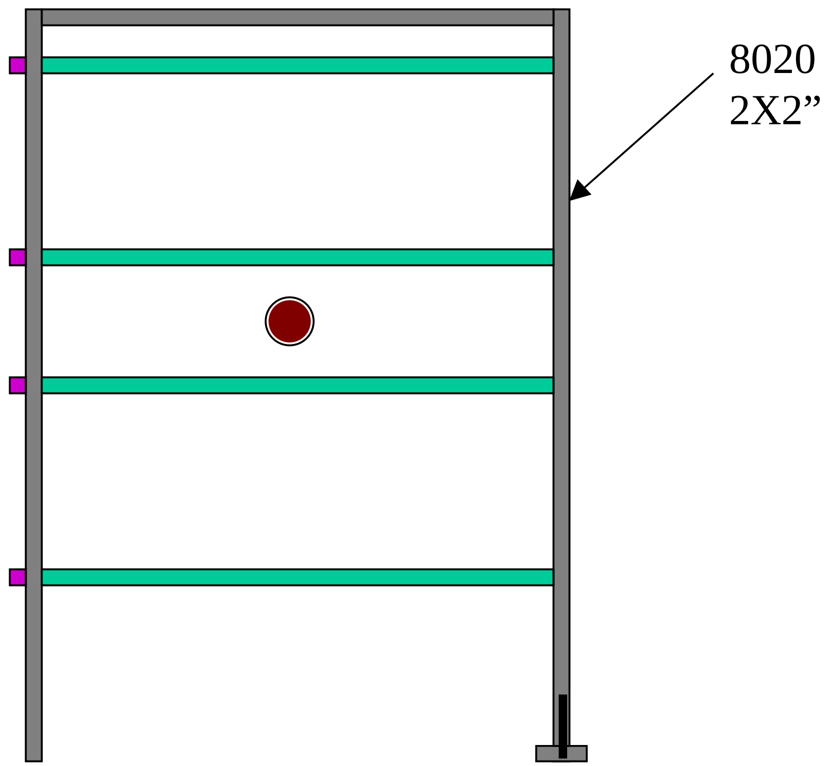
Main Coils

- Design impedance 1.8Ohm
- Design current 20-22A
- Design Voltage 36-40V
- Heat dissipation into cave
  720 W coils, approx. 50W air cooled parts of Danfysik

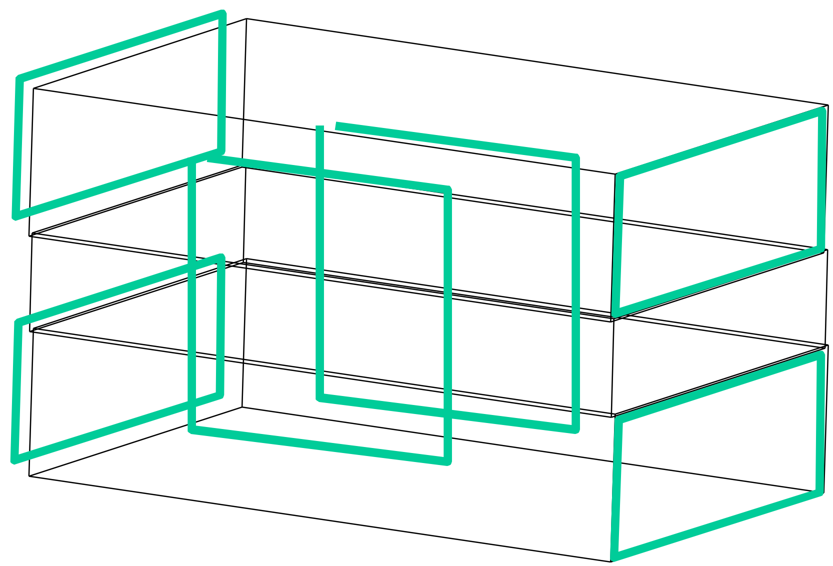
Side View of Stand



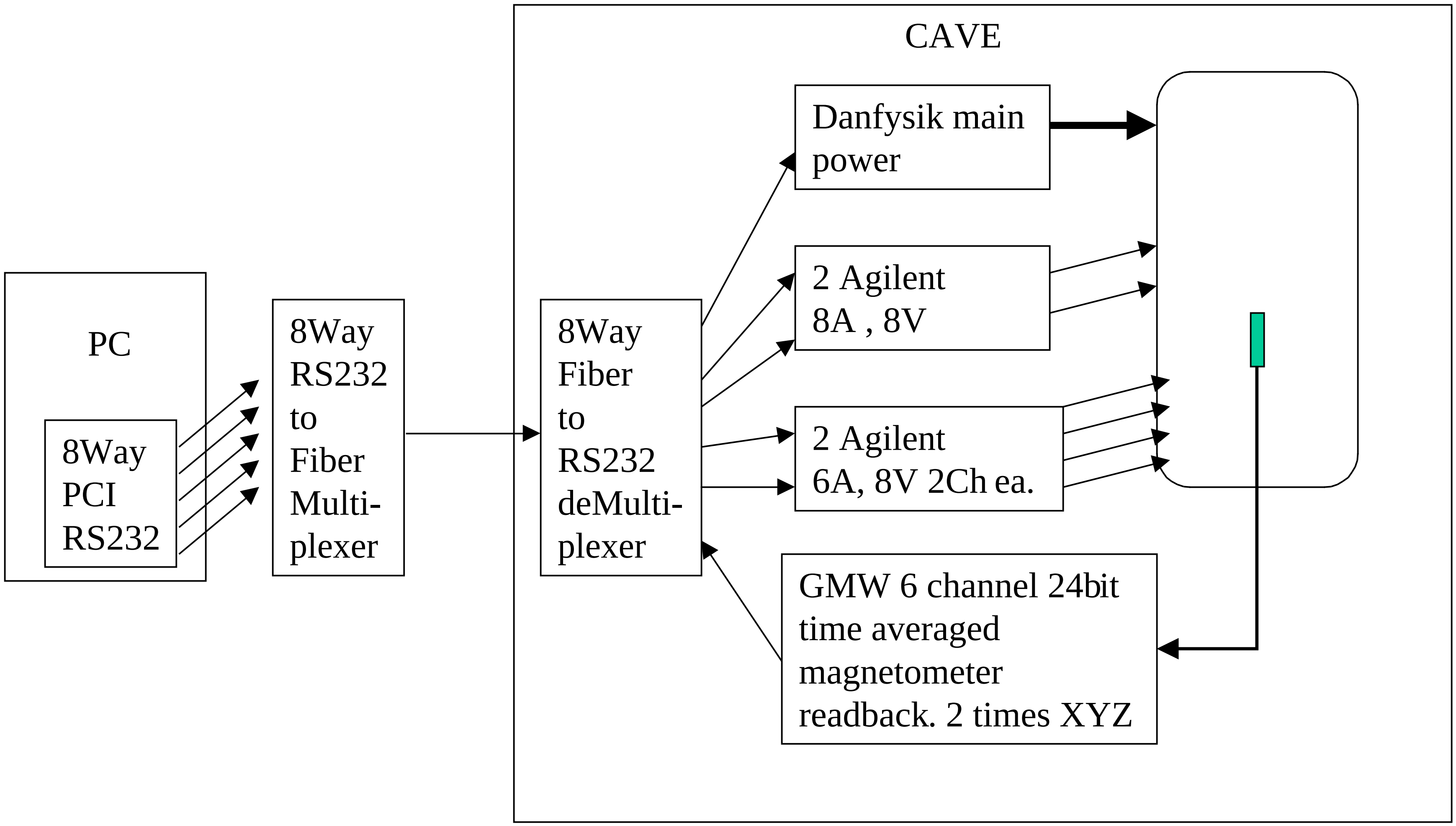
End View of Stand



Top View of Stand
(top transverse bars removed to see coils)



Guide Coils System



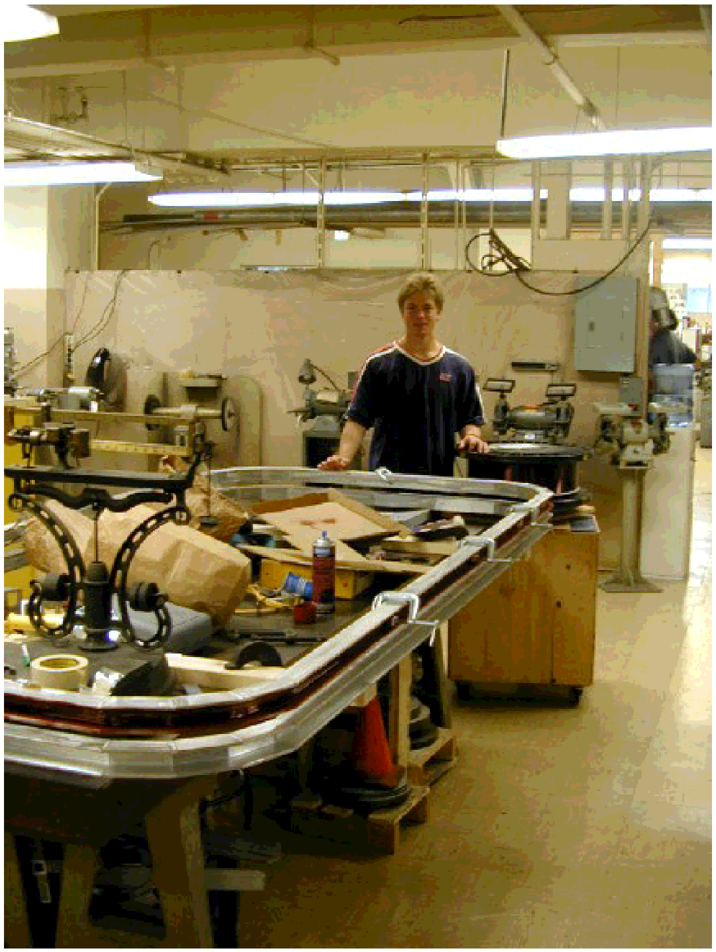
Some Features

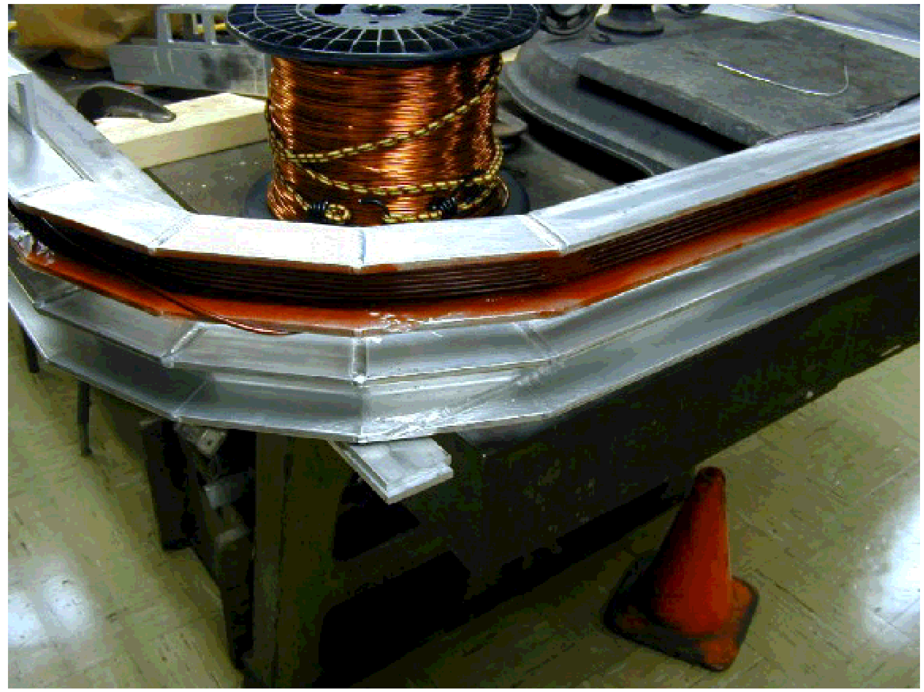
Even before control system is in place. All Power supplies can be reproducibly digitally programmed from the front panels, typically 4 digit settings.

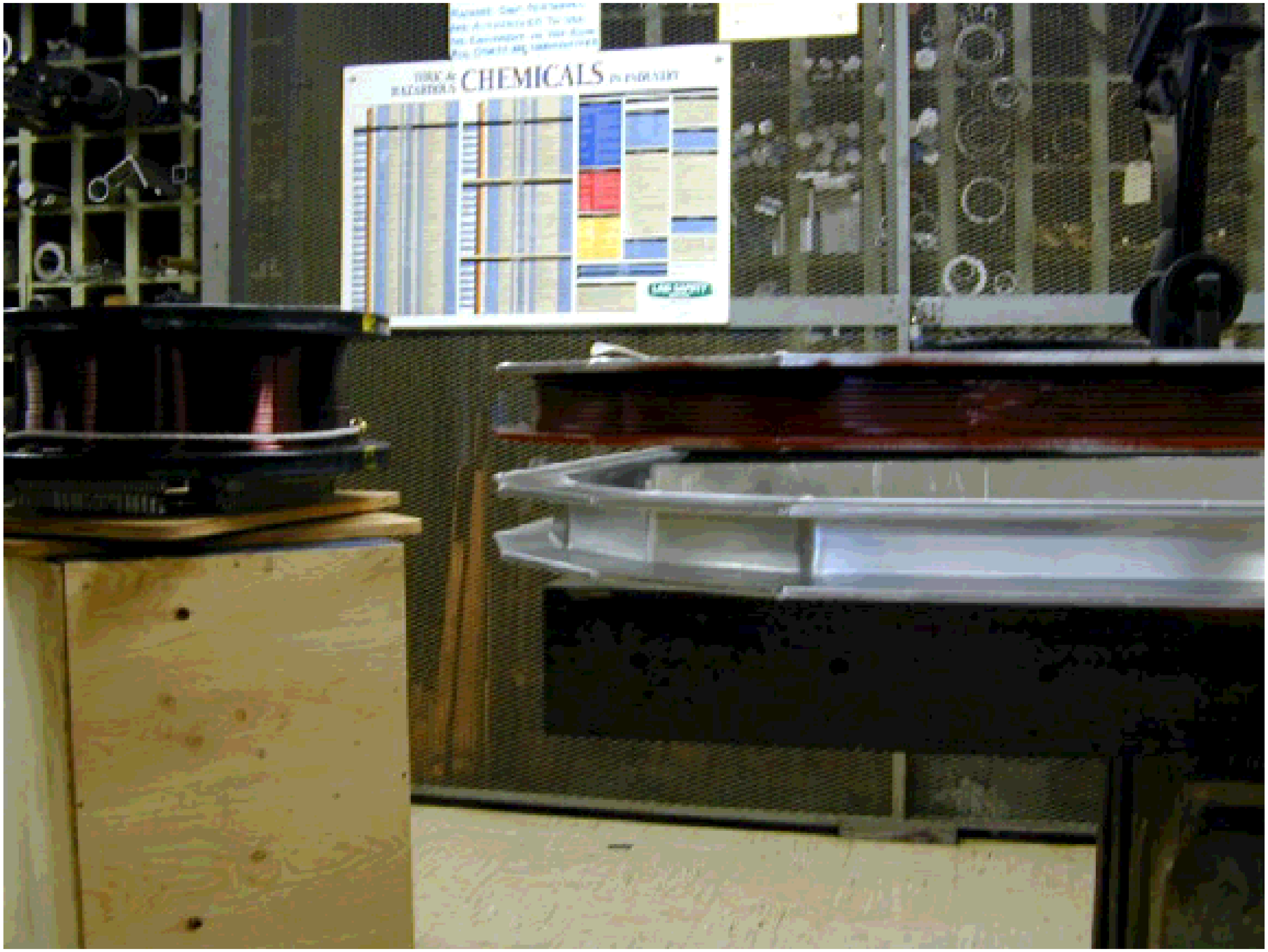
Good shimming of the He3 regions was achieved with additional double coil shims at the ends.

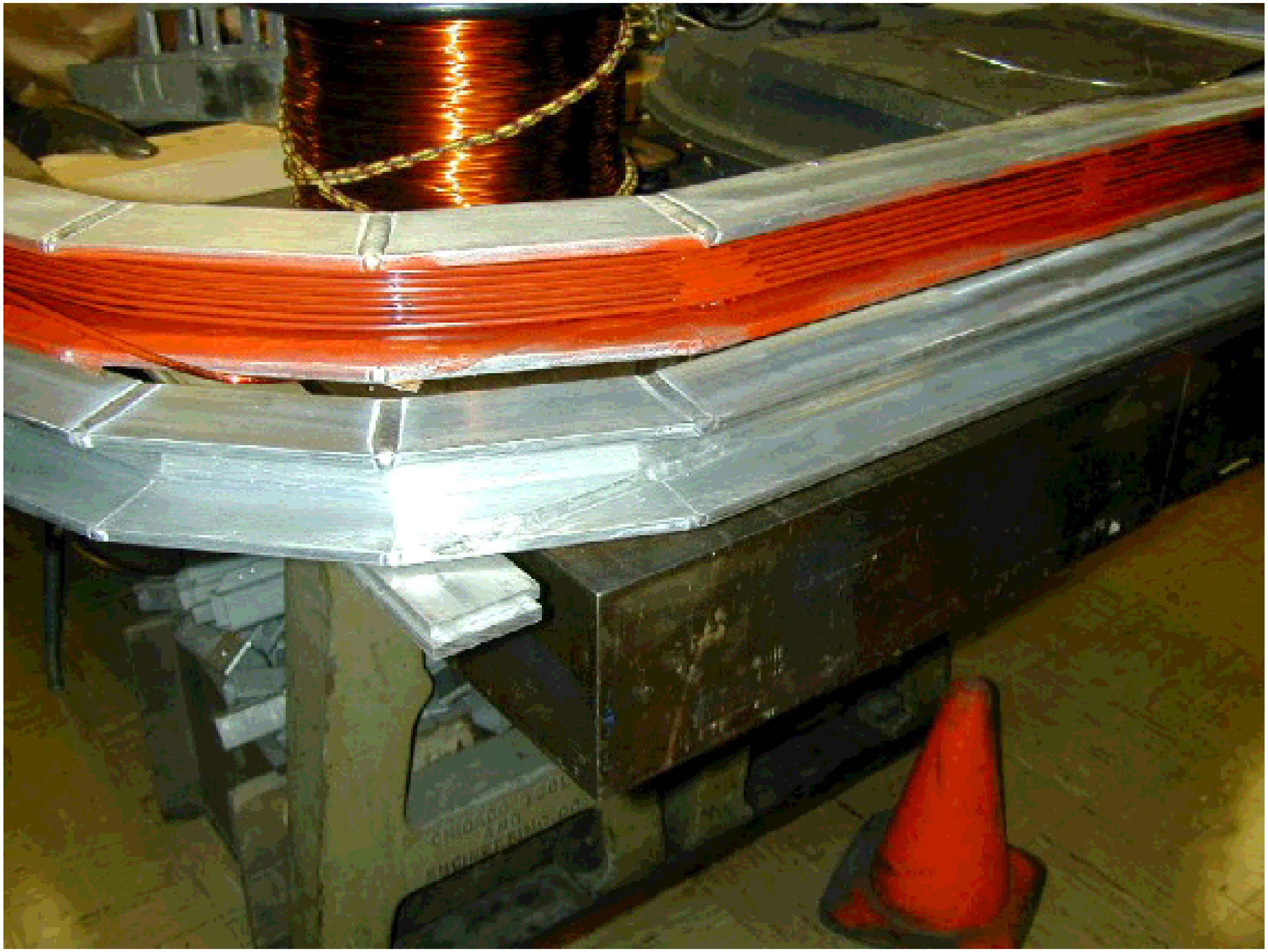
Tilt around axis can be control with two shim coils on the sides.
We have enough shim channels to independently control the fine current in all 4 main coils and in 3 additional shims.

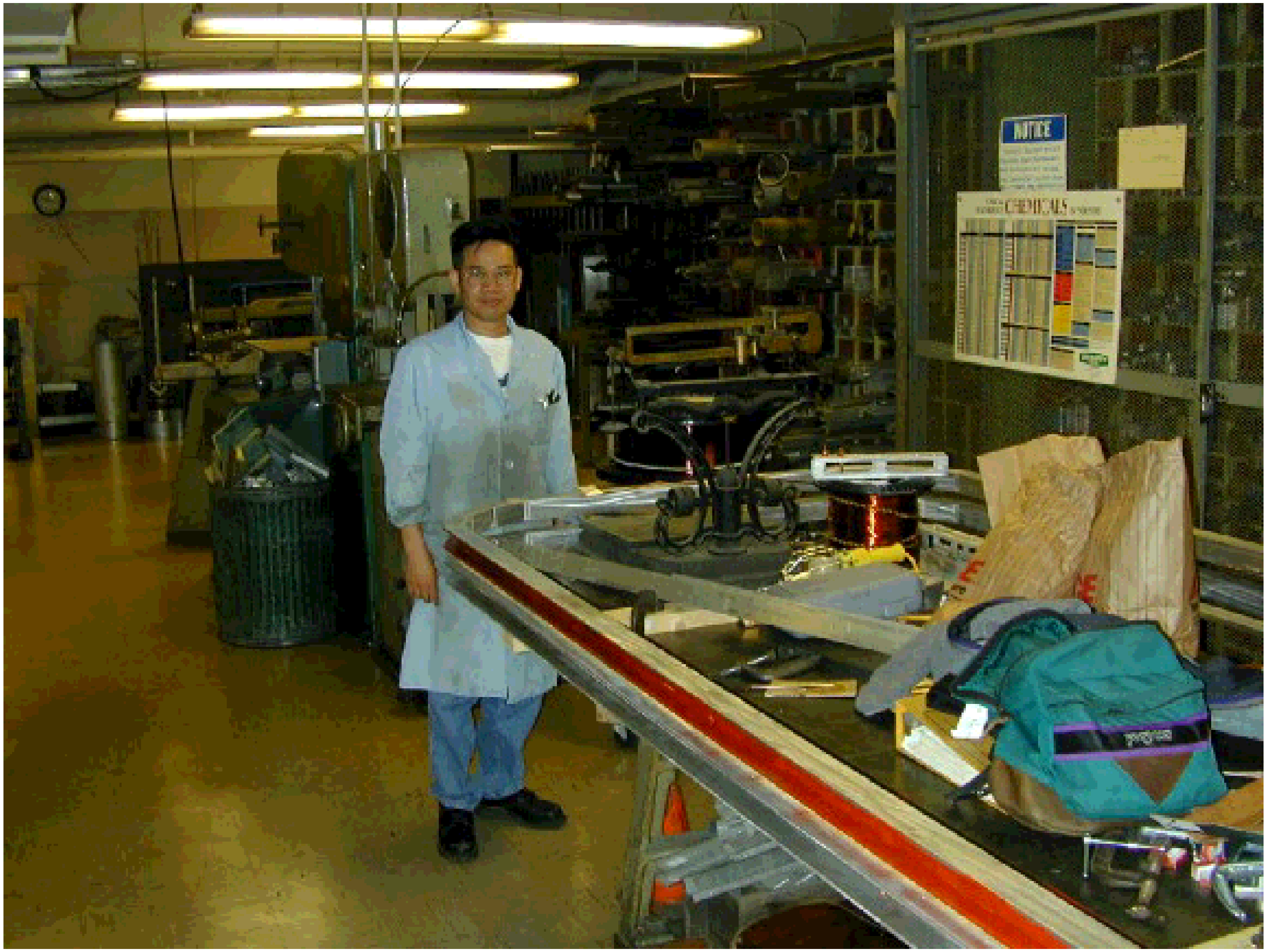
Two Rs232 ports are still free for future shim supplies if needed.

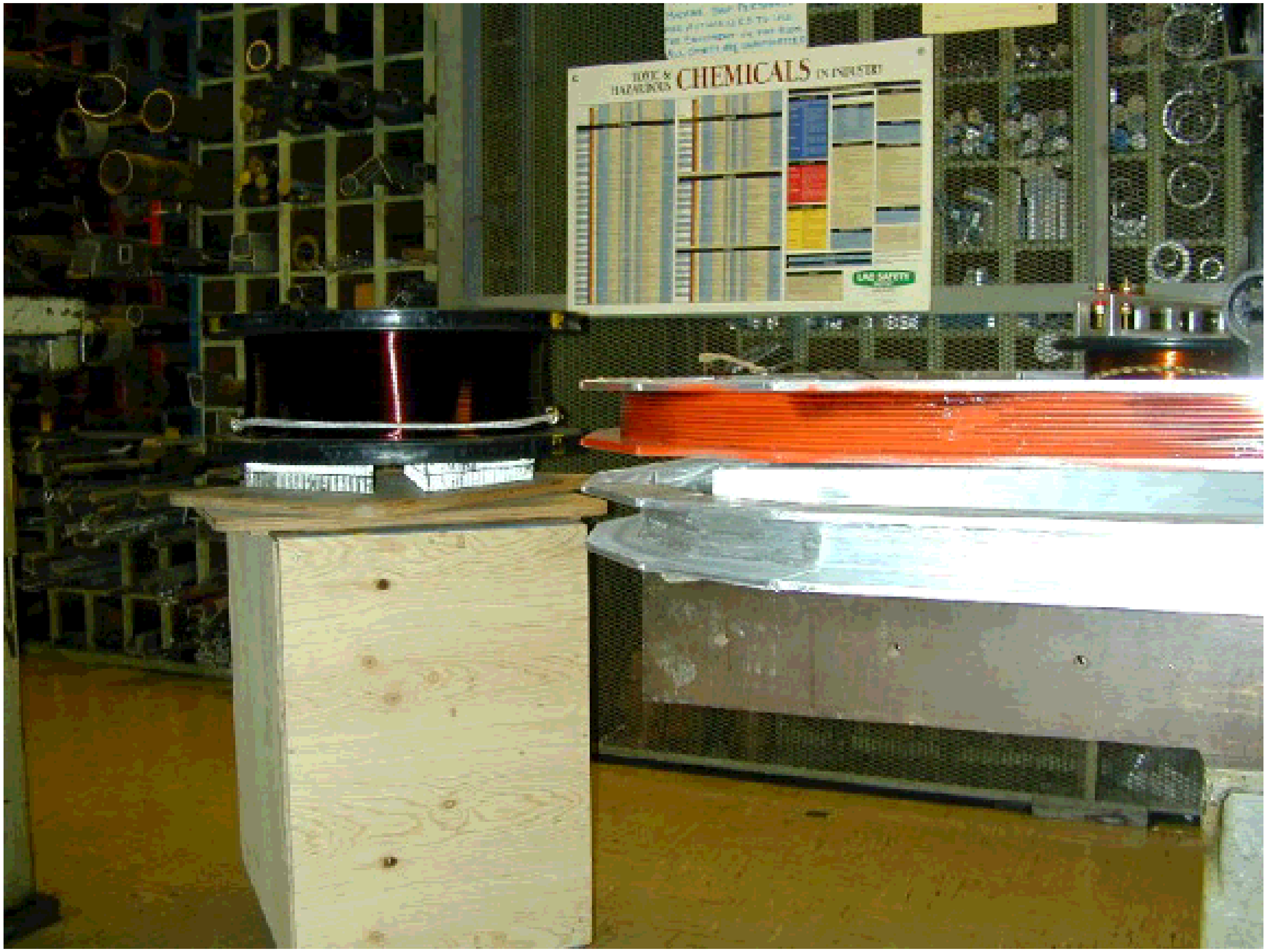




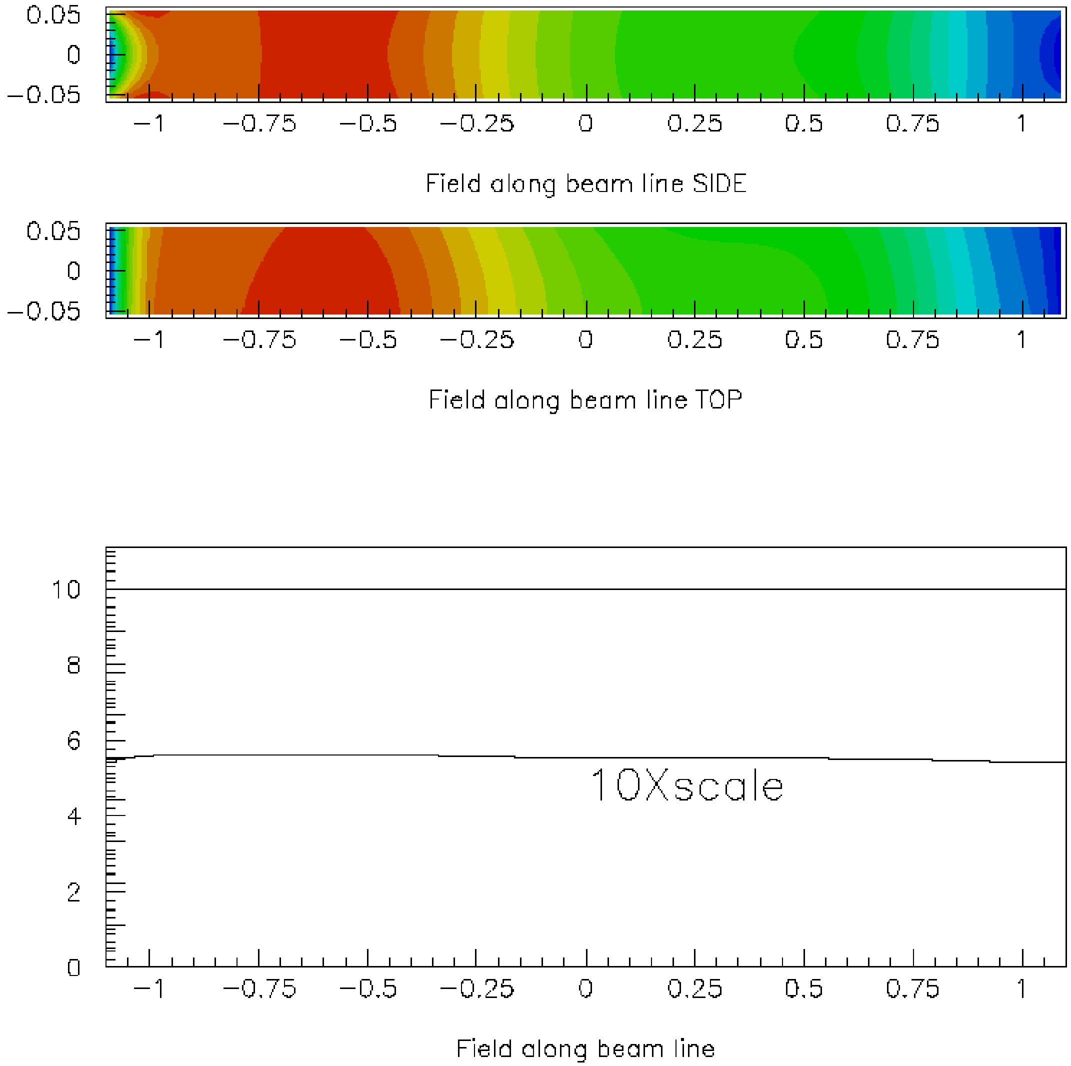

CHEMICALS




NOTICE
CHEMICALS

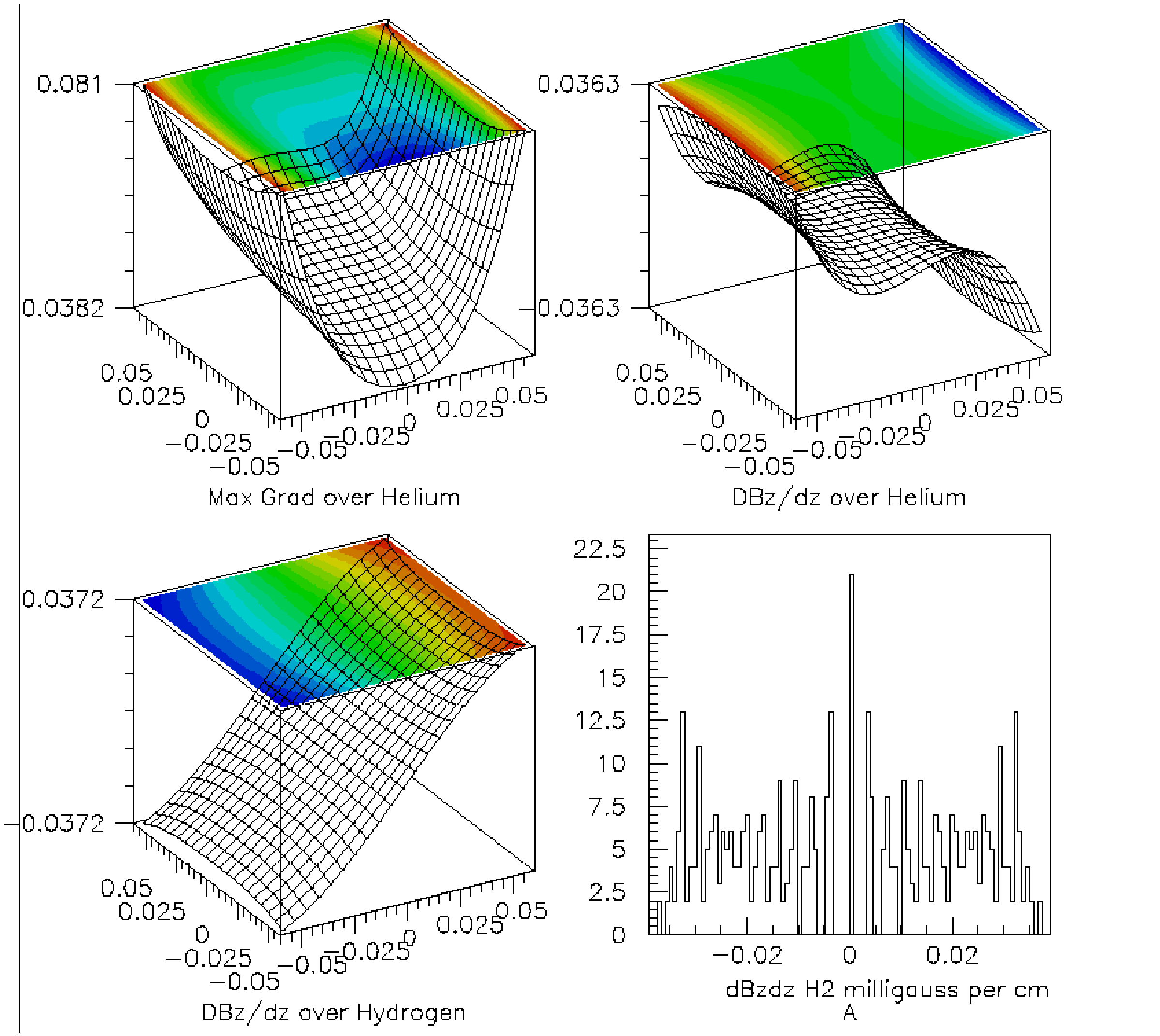

CHEMICALS

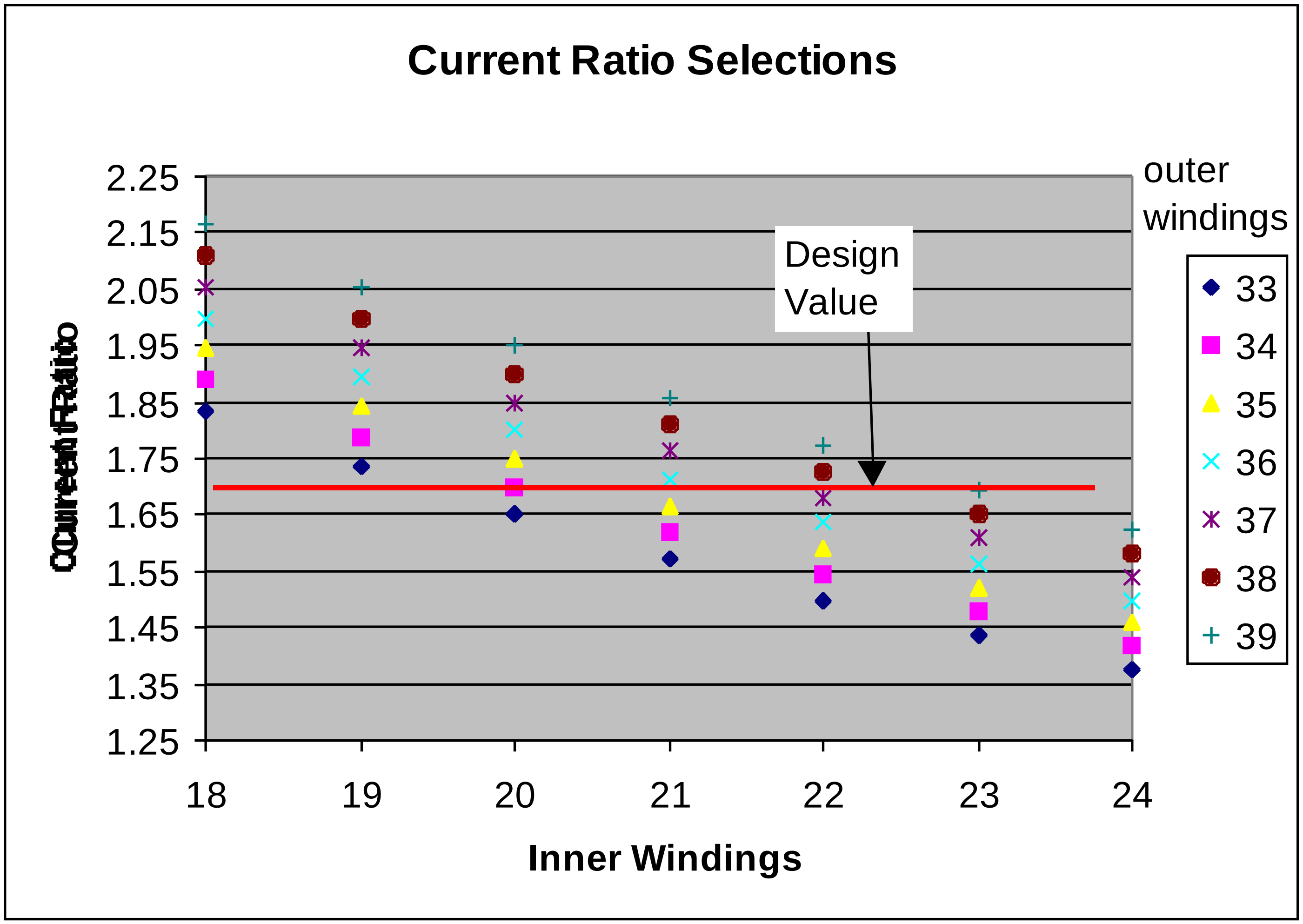
2 D - Plots



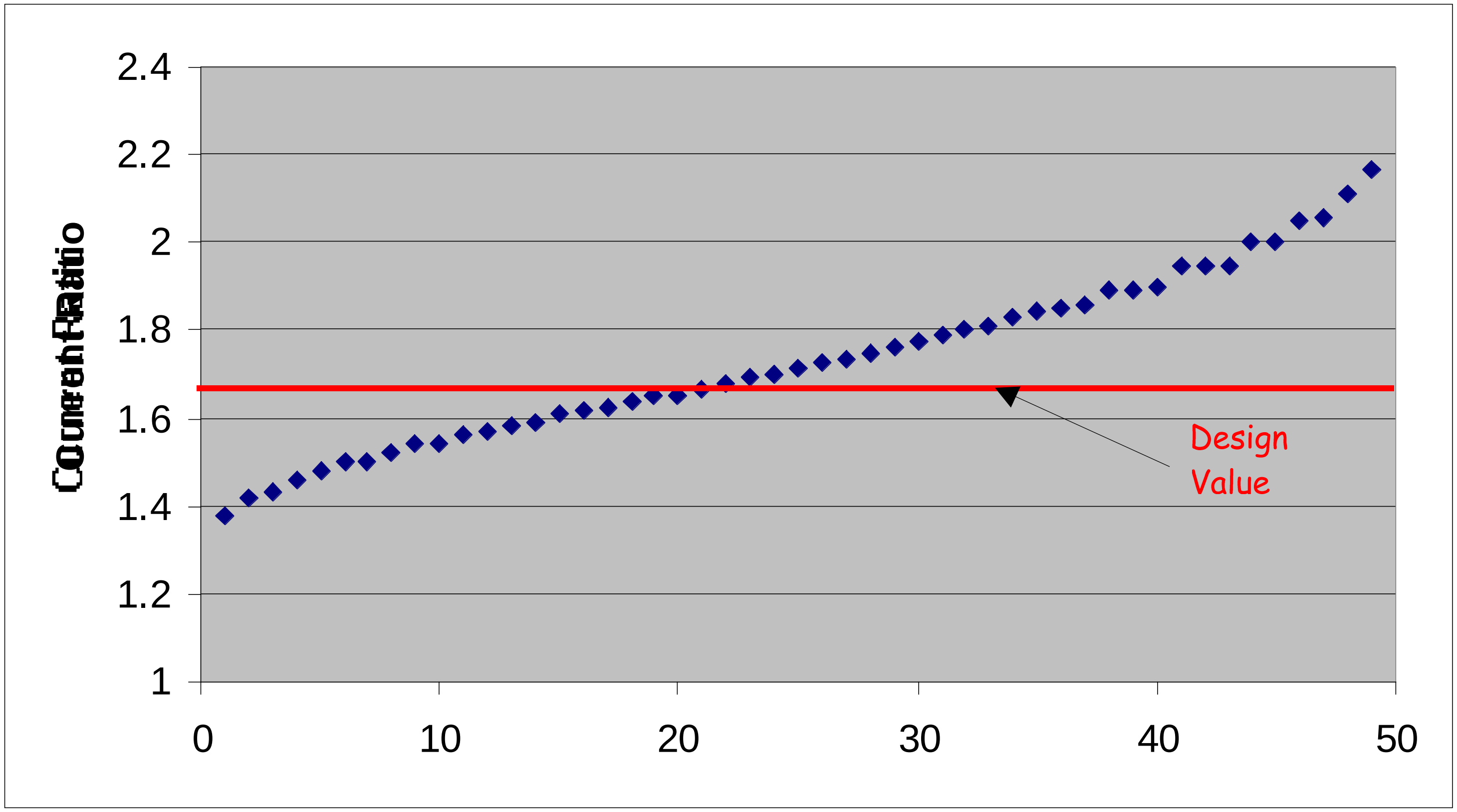
0.05
0
−0.05
−1
−0.75
−0.5
−0.25
0
0.25
0.5
0.75
1
Field along beam line SIDE
0.05
0
−0.05
−1
−0.75
−0.5
−0.25
0
0.25
0.5
0.75
1
Field along beam line TOP
10
8
6
4
2
0
10Xscale
−1
−0.75
−0.5
−0.25
0
0.25
0.5
0.75
1
Field along beam line

Gradients


0.081
0.0382
0.05
0.025
0
−0.025
−0.05
−0.05
−0.025
0
0.025
0.05
Max Grad over Helium
0.0363
0.0363
DBz/dz over Helium
0.0372
0.0372
DBz/dz over Hydrogen
22.5
20
17.5
15
12.5
10
7.5
5
2.5
0
−0.02
0
0.02
dBzdz H2 milligauss per cm
A


Current Ratio Selections
Current Ratio
2.25
2.15
2.05
1.95
1.85
1.75
1.65
1.55
1.45
1.35
1.25
18
19
20
21
22
23
24
Inner Windings
Design Value
outer windings
33
34
35
36
37
38
39

Current Ratio Possibilities without shims



1: Space for Shim windings

Planning up to 10 shim coils wound as needed on the periphery of the rectangular space formed by the shim coil support. Coils make spot corrections to the field after all shimming possibilities from moving the shim coils and adjusting their individual currents are exhausted. 10% of windings on each guide coil reserved for the shim circuits.

These coils should not need more than 5 or 10 turns and operate a few degrees above room temperature.

Only limitation on what fields these coils could create come from large surface areas inaccessible to the shim windings. Possibility to weave a few strands of shim cable between the legs of each apparatus if necessary.

2: Description of the Bartington fluxgate magnetometer

All Hall probes investigated were unreliable at milligauss and sub-milligauss levels. Using Bartington Mag-03MC1000 3 axis fluxgate magnetometer as the standard probe both for shimming and online monitoring of the field.

Device is based on tiny sliver of mu-metal (1mm Dia x 1.5cm). In operation, the mu-metal is kept at zero field by a bias coil wrapped around its length. Bias coil is approx. 5mm in diameter. Therefore, the effect of this magnetometer on the field it is measuring is well simulated by a field in the opposite direction to the measured field over a volume of approx.
3mm Dia x 1.5cm.

2: Description of the Bartington fluxgate magnetometer (cont.)

Simulated this bias current in the proposed position of the fluxgates and found that at the center of the beam line the field shift was only .05milligauss (discussed further below). Local supplier of these magnetometers used a second flux gate to measure the fringe fields of the first with the same result.

The Mag03-MC is 25mm diameter by about 20cm long. The X-Y-Z elements are located 14mm apart in the last 34mm of this probe.

This device has a normal range of +-10gauss. Limitation comes from the maximum bias voltage which is normally supplied by a battery in portable models. The specs say that we can externally supply up to 17volts to the probe giving a full range of +-15gauss which should be sufficient.

3: Two shimming steps, logistics of mounting coils and apparatus

Logistics of shimming the coils with no apparatus inside, then disassembling, mounting apparatus, and reassembling. Conclusion: there is no reliable way to reassemble the coils in exactly the same places as where they were first shimmed. (Precision struts will be provided so that the spacings between coils and their relative alignment can be reproduced with reasonable accuracy)

Still, the field must be measurable over the surface of a volume containing the beam line even while all apparatus is in its final position. And therefore, the designers of each apparatus must allow for the positioning of the magnetic field probe at enough reference positions around the apparatus to make a useful map for making the final shim.

Shimming would proceed in two steps:

First the 4 guide coils would be mounted with no apparatus inside. In this configuration the entire beam line and surrounding volume could be mapped uniformly to make a first study of the basic field characteristics and first order shim adjustments could be made, mostly by adjusting the coil positions and currents. Some custom wound shims could also be tested quickly, keeping in mind that they would be disassembled.

Second step, the racetrack coils are removed in the most reproducible way possible and all apparatus is mounted in final position. Then racetrack coils are placed back over all apparatus. By placing the field probe in all reference positions a new field map is made and used to make the final shim adjustments iteratively.

(Some precision reference marks/holes built into the guide coils so that the magnetic field probes can abe referenced directly to the guide field coordinate system without relying on the alignment of the other apparatus.)

4: Space for fluxgates

There must be enough reference positions around the experiment to make a useful field map. The most difficult place will be around the hydrogen target. The CsI detectors are a set of rectangles around the cylinder of the target. This leaves a series of small crevices around the target which could accommodate up to a 45mm diameter probe.

Probe is 5mm diameter so there seems to be sufficient room to measure the entire surface of the hydrogen target via sliding the probe down each crevice. Desire to have 4-8 reference positions on either side of the RF flipper and the 3He cells. Perhaps the downstream side of the RF flipper is already measured while measuring the the hydrogen target. Make sure that the 20cm probe tube does not hit any obstructions when being placed in the target crevices.

Alignment:

As manufactured the angles of the XYZ detectors in these probes are not guaranteed to more than 10mrad. Intend to mount machined surfaces onto these probes and determine the exact angles of each detector to 1mrad. Like to use similar machined surfaces on each reference position to line up the probe to each apparatus within 1mrad also. If edges of each apparatus cannot be aligned this well, then still like to have machined surfaces for reproducibility and will have to make a set of careful angle measurements of each important surface before the field map will make sense.

(Try to make this issue completely moot by making our own field probe supports attached with precision to the guide field coils. For not requiring precision alignment of the apparatus may need a little more access so the support struts from the field coils can reach all monitoring points to support the probes.)

5: Placement of magnetometers in running mode

Intent to leave 2 to 4 fluxgates in the crevices around the hydrogen target during the run centered over the middle of the drift zone. This would give an online readout of the field and field gradient during the run. Like to know if there will be any problems leaving a 25mm tube full of electronics between the hydrogen and the CsI? Two effects to worry about are discussed below.

6: Effect of fluxgate on field

Field shift from one Fluxgate would be about .05milligauss at the center of the beam line and .14milligauss at the edge. If 4 probes are used they should be spaced widely such that the maximum shift expected would be ~.2milligauss. This does not seem to be a problem.

7: Noise from flux gate

In operation the fluxgate probe uses a small oscillation field at 32kHz to sense the zero field state of the mu-metal. Probes are held in an aluminum can to shield most of this. Should insure that this noise does not affect the signal on the CsI. Arrange a test?

8: Magnetic materials database

Each time Tom evaluates the effects of a magnetic component on the drift field he has been adding it to a file of magnetic materials. So far it just contains the results for the cryopump motor, the fluxgates and a 361 stainless vacuum connector.

Status Summary

The last coil is being built this week

The 8020 stand and fiber link will be ordered shortly and all components will be at hand.

Development of control system Jan Feb 03

Shipment to LANL Mar. 1 03 setup and initial field and shim measurements.

Components could go earlier.

Magnetometer read back needs to be rewired for 15V instead of 12V to extend range from 10g to 13g.